IEEE PHILADELPHIA 1903 2003

IEEE in the Delaware Valley from 1903 to 2003

— *PART 3 OF 4* —

Electro-Technology has played an important role in the development of the Delaware Valley, and the IEEE has been instrumental in bringing together the professionals who have made it all possible.

During this, the Centennial Year of the IEEE Philadelphia Section, we are endeavoring to highlight many of the projects, products, and services that have taken place here. This is the third of four issues of the Almanack that will tell this story.

THE ALMANACK ISSUES WILL INCLUDE:

1. Electric Power Industry.
2. Consumer, Commercial, and Industrial Products and Communications.
3. **Computers and Instrumentation.**
4. Defense and Aerospace.

A good case can be made that what was accomplished within the territory of the Philadelphia Section is the most innovative and far reaching of any of the IEEE USA Sections. You can form your own assessment after reading this history.

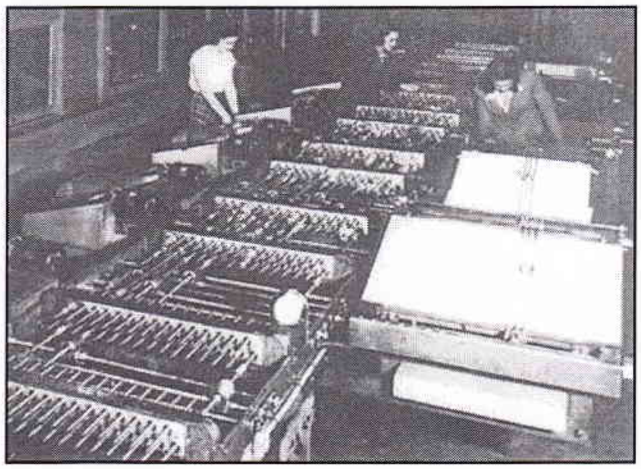
Computers and Instrumentation

— COMPUTERS —

UNIVERSITY OF PENNSYLVANIA

Differential Analyzer

The Moore School had been involved in the computing field for at least 10 years before the ENIAC (Electronic Numerical Integrator and Calculator). In this time it built small machines, but its outstanding production was the construction in 1933-35 of the differential Analyzer, which was a machine about 50 feet long and contained 14 integrators. It was an analog machine, based primarily on a development of Vannevar Bush of MIT, and carried out many analog operations. It was originally intended to help with non-linear equations of Moore School research. At the time it was built, the



Differential Analyzer

Moore School of Electrical Engineering had virtually no funds for the project but great good fortune matched the idea to the times (curiously, since it was 1933-35) and a machine of about $200,000 value was achieved in 1935.

Only two other machines of this type existed, one at MIT, the other at the Army Aberdeen Proving Grounds in Maryland.

When World War II came along, the capacity of the Differential Analyzer at the Ballistic Research Laboratories at Aberdeen, was exhausted with calculating mostly firing tables for artillery projectiles. The Moore School's Differential Analyzer came to its aid, which was running around the clock. Lt. Herman H. Goldstine supervised the Aberdeen Proving Grounds Contract. He later sold the Army Ordinance the idea of an electronic trajectory computer, which the Army subsequently named the ENIAC.

ENIAC — Computer Development at the Moore School of Electrical Engineering

By J.G. Brainerd, LF '69

The ENIAC, which was conceived, developed, designed and built entirely within the Philadelphia section, and specifically in the Moore School was the world's first large-scale digital electronic general-purpose computer. The history of its inception and creation has been

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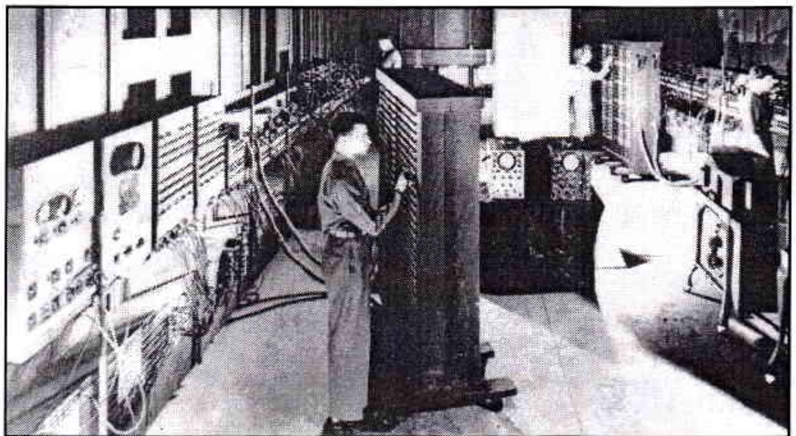

ENIAC Computer

told in many articles and books, and the ENIAC has become a matter of historical importance. To summarize extremely briefly: a stimulating memorandum was written by John W. Mauchly (Assistant Professor), given to J. G. Brainerd (Professor and supervisor of other war research projects), and then discussed with Lt. Goldstein (liaison officer with the Army Ordnance Department, stationed at the Moore School), who effectively sold the idea to two superior officers. The result was that the University submitted a formal proposal and was awarded a contract for the R&D work.

Under the contract the project was the responsibility of the University, and within the University, by agreement of two responsible officers, Brainerd was placed in complete charge of the project, a position, as he afterwards said, he would not have taken if he did not know that he could transfer J. Presper Eckert, a brilliant instructor and graduate student, to the new project.

The ENIAC project began June 1, 1943, and the machine was dedicated February 1946. It was a huge affair containing 18,000 vacuum tubes, almost four times that number of resistors, and it had a frame about 80 feet long arranged in the form of a U. ENIAC required environmental cooling and several technicians around the clock just to replace the vacuum tubes.

The first paper ever written about large-scale electronic digital general-purpose computers was the description of the ENIAC, which appeared in February 1946 in The Pennsylvania Gazette, the Penn Alumni magazine. The first article of potential application of large computers to business problems was written by Adolph Matz, Professor of Accounting in Penn's Wharton School, and appeared late in 1946 in a professional accounting journal. That paper had an interesting short history in that it was rejected originally as too ephemeral, but apparently the publicity, which accompanied the dedication of the ENIAC, changed the editor's mind.

The Moore School went on to build a second computer, the EDVAC, which was larger mathematically, but far smaller and more efficient physically, and had stored memory. It was not, however, the second of the big computers because Maurice V. Wilkes, Professor at the University of Cambridge, England, finished his EDSAC sooner. The EDSAC was a machine for which Professor Wilkes set up a project immediately after visiting the Moore School.

Later, the Moore School produced the plans for the UDOFT (Universal Digital Operational Flight Trainer) under the direction of Professor Morris Rubinoff. At the time, this was the most flexible such device ever designed. It opened the field to training with groups of planes simultaneously, rather than with just one. The UDOFT was built by a commercial organization to the Moore School plans.

ENIAC weighed 30 tons, and occupied 1,500 square feet of space on the first floor of the Moore School. It was capable of performing 300 multiplications per second. By contrast, the fastest electromechanical devices at the time could only do one multiplication per second.

John W. Mauchly

Abstracted from an interview by Marian F. Fegley

John W. Mauchly

The circumstances which shape our lives, are varied, often curious. One might often wonder what inspired the great inventions that changed the course of many lives. John W. Mauchly related his story of one such invention, ENIAC, the first all-electronic computer, as the attainment of a long sought goal. Many factors had combined to inspire him to build a calculating machine which would do more and do it faster that any equipment than known It did not happen in a flash, but required years of

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working toward the goal despite much discouragement from others This work continued even after the ENIAC was completed.

John Mauchly attended public school in Washington, D.C., where his father was head of the Section of Atmospheric Electricity of the Department of Terrestrial Magnetism of the Carnegie Institute of Washington from 1913 until his death in 1928. As a high school student, John would occasionally help take measurements in his father's office.

With the encouragement of a high school teacher, he applied for a scholarship at the Johns Hopkins School of Engineering. After two years in the School of Engineering, he abandoned his Maryland State scholarship and was accepted as a New Plan student in physics. Under this plan, he mixed graduate and under-graduate courses. In 1932, he earned his Ph.D. in electrospectroscopy without stopping for a bachelor's or master's degree.

He remained at John Hopkins as an assistant in physics for another year, after which he was named professor of physics at Ursinus College.

Statistics began to draw his attention. First, he used statistics for a new problem, comparing his students with those in other American colleges and universities. Standardized tests, which were constructed and measured statistically, were available. Statistical studies and analyses were not generally applied to physics or chemistry in those days.

A second-hand oscilloscope purchased by Mauchly was used by physics students during the day, but at night was used to put together circuits to count pulses to make an electronic calculator. The idea seemed rather obvious to Dr. Mauchly, as it was similar to the method then used to count cosmic rays. Thus the idea of an electronic calculator was conceived as Mauchly and his student assistants processed some of the mass of geophysical data. He believed that all one needed was suitable inputs from keyboards or punched cards and outputs to punched cards or printers. He also realized that to be really useful, the equipment must be able to store information and remember a set of instructions on what to do with the numbers.

About this time, he built an analog computer with 12 input knobs and one output knob. This was used to analyze the tide in the atmosphere as it's affected by the sun and the moon. Calculations which required 20 minutes using a desk calculator could be done in 2 minutes with the analog computer and a reading meter. The results looked interesting, but so much more data needed to be analyzed before truly significant results could be obtained.

About 1940, Dr. Mauchly believed that he had to get the electronic computer program started. Since Ursinus College did not have the funds for such a project he considered industry, government service, and other academic institutions. At the same time, he sought opportunities to learn more about calculating instruments already in existence or proposed. He spoke freely of his ideas hoping for both support and suggestions.

A graduate course on the theory of design of computing instruments at the University of Pennsylvania attracted his attention because of Penn's differential analyzer. When Penn offered a summer defense training course in electronics in the spring of 1941, he was quick to apply, knowing that those completing courses would be considered hired in a defense industry.

He went to Iowa State College (now Iowa State University) to see Dr. John V. Atanasoff, who was building a computer (far from completion) with the help of graduate students. While there, he heard that he had been accepted for Penn's summer course. Dr. Atanasoff and Mauchly had met at an American Association for the Advancement of Science meeting over a year earlier where Mauchly had presented a paper in which he mentioned his idea for an electronic computer.

Since the laboratory work for the course was about the same as that which the Ursinus professor assigned to his senior physics students, he spent much of these periods discussing with the laboratory instructor, J. Presper Eckert, Jr., the possibilities of building a computer. Upon completion of the course, Mauchly was offered and accepted a teaching position at Penn's Moore School.

The Moore School's differential analyzer was being used by Army Ordinance to supplement its twin at Aberdeen Proving Grounds. Both were hard at work for the Ballistic Research Laboratories, calculating firing tables of the path along which projectiles travel when fired.

When Lt. Goldstine, who was supervising the Aberdeen Proving Grounds contract at the Moore School, learned about Mauchly's ideas, he was fired with enthusiasm and asked Mauchly to submit a development proposal to the Army.

The proposal was made in early April and a contract for research into an electronic trajectory computer with the Ordinance department of the U.s. army became effective July 2, 1943. Mauchly and Eckert set to work on the design with a team of 12 engineers. The computer they designed was not like any previously described in print. It was essentially a repetition of may common parts which would accept decimal numbers, give decimal output, and provide a decimal storage device. Every bit of circuitry was built to operate on the "all or none" principal. Many design principles were established at the start. Mauchly said (before his death), "I think of Eckert as being one of the first people who deserve the title of reliability engineer." The actual value of resistors and the performance of vacuum tubes available in 1943 varied widely. Dr. Eckert designed the circuits so circuit performance would be independent of circuit current.

In December of 1945, the monstrous machine was completed. The electronic numerical integrator and calculator, dubbed ENIAC by Army Ordinance, had a half million parts and over 18,800 vacuum tubes of only 10 types,

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60 kinds of resistors, and 30 kinds of capacitors.

In mid-February 1946, various news media carried the announcement that the ENIAC, an electronic computer, had been invented by J. W. Mauchly and J. Presper Eckert, Jr., and built at the Moore School.

The ENIAC, which required about 3 ms for a multiplication, or did 5000 additions a second, promptly made relay calculators obsolete from the scientific viewpoint for they had a top speed of about 10 additions per second. During its first months at the Ballistic Research Laboratories, for a typical week of actual work, ENIAC was equal to 500 human computers working 40 hours with desk calculators. It was anticipated that this rate would double or triple as the operators gained experience. While designed primarily to calculate trajectories, the ENIAC was modified during the building to enable the machine to calculate a very wide class of problems. It had two major limitations: its storage capacity was at most 20 numbers (of 10 decimal digits each) and the instructions had to be set up through a slow manual process of wire plugging or switch setting.

Although the ENIAC did not have a large storage device, the 1945 report gave a clear recognition of both the problems and the advantages to be gained through the availability of such a device. Actually the realization that this was needed and could be included came in 1944. This was a crucial point as the ENIAC design was well underway. As there was so much skepticism about its ability to function as proposed, work was continued on the original design. The ideas were recorded and later incorporated in the EDVAC, built at the Moore School, the UNIVAC designed by Eckert and Mauchly and subsequently produced by Remington Rand, and the smaller BINAC.

The application for a patent on the ENIAC was the longest ever filed up to that time, June 1947. No one in the patent office was then qualified to examine it. The patent was issued 17 years later, nearly 8 years after ENIAC had been dismantled following 10 years of continuous operation at Aberdeen Proving Grounds.

J. Presper Eckert, Jr.

John Presper Eckert, Jr. was co-inventor of the mammoth ENIAC computer in 1945. Working under an Army contract in World War II to automate artillery calculations, Mr. Eckert and Dr. John W. Mauchly designed a computer with more that 18,000 vacuum tubes that received instructions through hundreds of cables resembling an old time telephone switchboard.

The 30-ton Electronic Numerical Integrator and Computer (ENIAC) was assembled at the Moore School. It could complete in 30 seconds a trajectory calculation that took a clerk 20 hours. Stacks of punched cards provided the data, which at times included work for the Manhattan Project.

John Presper Eckert, Jr.

Although ENIAC resembled a scene from a 1950's science-fiction movie, its flashing pink lights, clicking switches and miles of cables hid a design remarkably similar — in concept, at least — to modern computers.

Mr. Eckert is credited with having solved the thorny problem of reliability by running the delicate vacuum tubes, which failed often, at low voltage and avoiding brittle solder connections by relying on hundreds of old-fashioned plugs. By rearranging the plugs and their cables, the computer could be reprogrammed to solve a wide variety of problems.

J. Presper Eckert, Jr., as he preferred to be known, was born in Philadelphia. He earned a bachelor's degree at the Moore School and joined the faculty shortly after graduation.

In 1943, he earned his master's and began collaborating with Dr. Mauchly on solving the problem of compiling the ballistics tables that artillery officers use to aim their guns.

For centuries artillery officers labored over those calculations, and a small error could be disastrous. Many variables, including wind, humidity, target elevation, distance and shell weight, made the calculations extremely complicated and caused the Army to issue volumes of hand-compiled tables.

Mechanical calculators helped, but the Army spent much of World War II looking for a way to avoid recalculating thousands of tables whenever even small changes were made to the artillery.

In addition, the Manhattan Project severely strained even the most accurate mechanical calculators, which were Rube Goldberg Devices that used motors, generators, photoelectric cells and vacuum tubes. ENIAC, not unplugged until 1955, was the answer to both problems.

Mr. Eckert retired from Unisys in 1989, but continued to be a consultant.

Mr. Eckert, who obtained 87 patents, received an honorary doctorate from the University of Pennsylvania in 1964. In 1968, President Lyndon B. Johnson awarded him a medal for his work as co-inventor of the computer.

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Grace Hopper

Commodore Grace M. Hopper, USNR – Official portrait photograph, taken 20 January 1984.
Photographed by James S. Davis

Rear Admiral Grace Hopper was a mathematician, computer scientist, systems designer, and the inventor of the compiler. Her outstanding contributions to computer science benefited academia, industry, and the military. In 1928, she graduated from Vassar College with a B.A. in mathematics and physics and joined the Vassar faculty. While an instructor, she continued her studies in mathematics at Yale where she earned an M.A. in 1930 and a Ph.D. in 1934. Grace Hopper is known worldwide for her work with the first large-scale digital computer, the Navy's Mark I. In 1949, she joined Philadelphia's Eckert-Mauchly, founded by the builders of ENIAC, which was building UNIVAC I. Her work on compilers, and on making machines understand ordinary language instructions, lead ultimately to the development of the business language, COBOL. Grace Hopper served on the faculty of the Moore School for 15 years, and in 1974 received an honorary degree from the University.

ECKERT-MAUCHLY COMPUTER CORPORATION

Soon after the ENIAC development, Drs. Eckert and Mauchly formed the Electronic Control Company, which subsequently became the Eckert-Mauchly Computer Corporation. In 1949, this company completed a computer called BINAC (Binary Automatic Computer), which was believed to be the first machine to be programmed by internally stored instructions. Designed for scientific applications, BINAC was built under contract to the Northrop Corporation, California.

The development of BINAC served as a test vehicle of plans Eckert-Mauchly had formulated for the UNIVAC®I (Universal Automatic Computer). UNIVAC I was the world's first, general-purpose commercial computer able to handle a wide variety of applications.

An alpha-numeric machine, UNIVAC I made extensive use of peripheral equipment — card reader, magnetic tape units and printer. Another significant feature was that it was able to simultaneously read new information, compute information just read and record the output results.

Data and program instruction were all stored in a mercury delay line memory. Information could be recycled in the line in the form of acoustical pulses. After pulses traversed the length of the mercury, they would be read and automatically introduced again to the beginning of the line. This process could go on indefinitely while needed information could be accessed as fast as 200 ms.

REMINGTON RAND

The Eckert-Mauchly Computer Corporation was acquired by Remington Rand, Inc. in 1950, and work continued on the UNIVAC I development. The first UNIVAC I was supplied to the United States Bureau of the Census in March 1951.

The UNIVAC I central processor weighed 16,000 pounds and used more than 5,000 vacuum tubes. It could perform about 1,000 calculations per second.

UNIVAC I became famous for its use in predicting the outcome of the 1952 Presidential election — the first time a computer was used for this purpose. The computer predicted that Eisenhower would defeat Stevenson by 438 electoral votes to 93. The actual count turned out to be very close to this — 442 to 89 in favor of Eisenhower.

In 1952, Remington Rand made a second acquisition in the data processing field by purchasing Engineering

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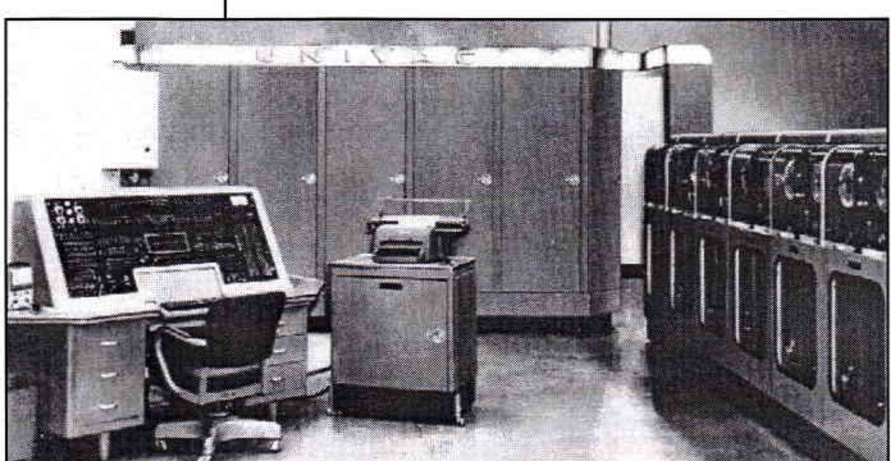

UNIVAC I Computer

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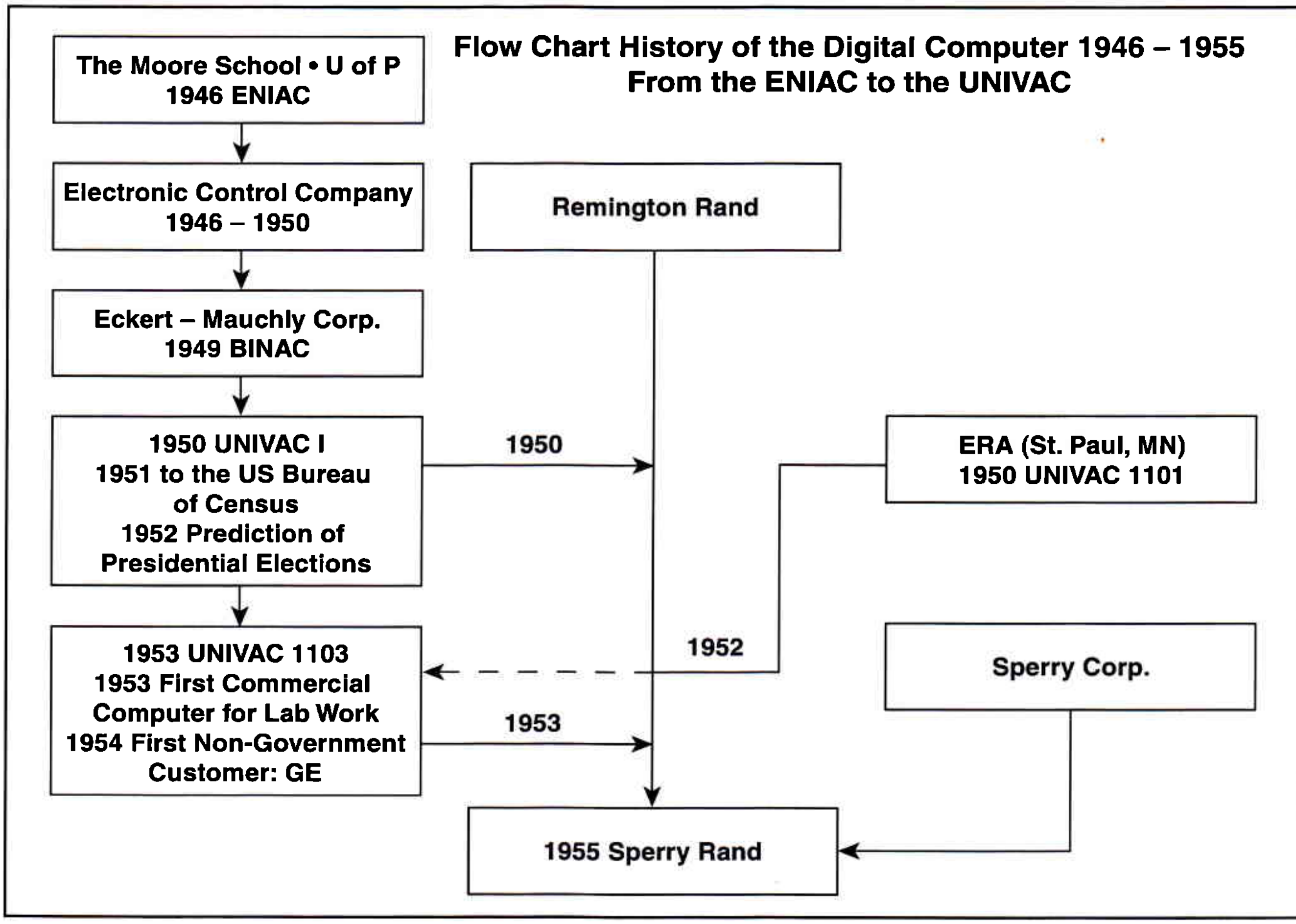

Research Associates (ERA) of St. Paul, Minnesota. ERA consisted of a group of mathematicians and engineers who, during World War II, had been active in the development of electronic cryptographic equipment.

After the war, ERA entered the data processing field and, in 1950, delivered the first scientific computers in the United States to the U.S. Navy and Georgia Institute of Technology. Later known as the UNIVAC 1101, these machines were markedly different from the UNIVAC I.

In contrast to the UNIVAC I's mercury delay line memory, the UNIVAC 1101 stored programs and operating data on the surface of a rotating magnetic drum. This early work with magnetic drums proved to be an invaluable experience for subsequent development of on-line, real-time systems.

The 1101 is believed to be the first electronic computer that was used in a real-time, on-line mode. It was directly connected to the wind tunnel at the Wright-Patterson U.S. Air Force base in Dayton, Ohio. This analog information recorded by sensors in the wind tunnel was converted to digital form, transmitted to the computer, processed by the computer, converted again to analog form, and fed back to the wind tunnel to help control and adjust its performance.

In 1953, the 1103, an improved version of the 1101, was produced. (See the ENIAC to UNIVAC Flow Chart above.) This was the first commercial computer to be delivered to a customer with coincident current magnetic core storage. The UNIVAC 1103 was 2,000 time faster than the 1101.

During the early 1950's, following the installation of the Bureau of Census UNIVAC I, computers started to move out of the laboratory and into the business world. In 1954, the first system delivered to a non-government customer went to General Electric in Louisville, Kentucky.

SPERRY RAND CORPORATION

In 1955 Remington Rand and Sperry were consolidated to form Sperry Rand. Univac became a separate division of Sperry Rand in 1962. The division name was changed to Sperry Univac in 1973, and the corporate name to Sperry in 1979. (See Flow Chart on Page 13.)

Simultaneously, there were several facility changes

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going on during this period of computer development in the Philadelphia area. After leaving the University of Pennsylvania, Eckert and Mauchly established their company at 1215 Walnut Street. In 1948 they moved to Broad and Spring Garden Streets, also in the center city area. In 1949 the company moved to Ridge Avenue in North Philadelphia. Subsequently, after Remington Rand acquired control, the Eckert-Mauchly division was headquartered at three separate locations on Allegheny Avenue in North Philadelphia between 1952 and 1955.

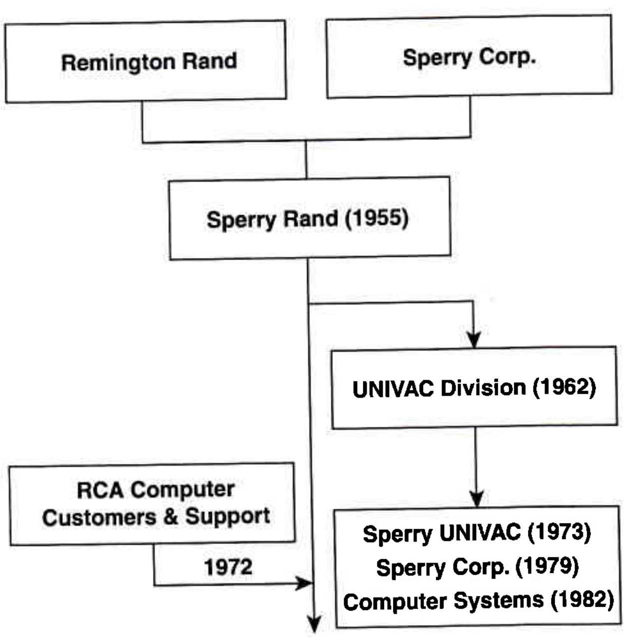
In 1961, a Univac Engineering Center was established in Blue Bell, PA, and gradually the company's personnel were relocated from North Philadelphia. The Blue Bell site became the world headquarters in 1966.

Sperry pioneered many computer advances, originating or improving upon major historical developments in the field of data processing. These improvements have spanned every generation of computers from those in the era of vacuum tubes, to the introduction of transistors, and later to semiconductor integrated circuits. Main memory developments progressed over the years from mercury delay lines and magnetic drums to ferrite cores, plated wire and then to integrated circuit technology.

Progress in the development of peripheral equipment kept pace with improvements in the central processor. Through the years, refinements and new engineering techniques produced peripheral equipment with even higher operating speeds and greater capabilities.

With the growth of data communications, production of both the printer and visual display type of remote terminal became a major part of Sperry manufacturing.

Flow Chart History of Sperry Corporation



Another area in which Sperry excelled was the development of real-time computers. The development of the first operational real-time computer originated in 1954 when the US Navy asked Sperry to help in the development of a system that would instantaneously and automatically accept, process, and display vital tactical information in shipboard combat centers. Sperry subsequently designed and built a real-time computer that was known as NTDS (Naval Tactical Data System). One such system, which enables all the fighting and maneuvering of a task force to be coordinated from the bridge of one ship, was installed in the 85,000 ton aircraft carrier USS Enterprise.

The experience obtained in developing the naval system was later incorporated in the first commercial real-time systems introduced by Sperry — the 490 Series of computers.

Real-time systems, which were a prominent part of the Apollo (Man-on-the-Moon) program conducted by the National Aeronautical and Space Administration (NASA), are installed at control centers in the United States as well as on land and ship tracking stations throughout the world.

Sperry computers formed the heart of the NASA world-wide communications network (NASCOM) centered at the Goddard Space Flight Center in Greenbelt, MD. In addition to the NASCOM network, several Sperry 1218 model computers assisted NASA operators in monitoring the astronauts' physical condition on missions, as well as the spacecraft's on-board systems during the six-minute pass over the tracking stations. Other Sperry systems were used in the NASA facilities at Goddard, Slidell, Houston, and the Marshall Space Flight Center at Huntsville, Alabama.

Another NASA project in which Sperry computers played a major role was the Mariner program for the exploration of the planets, conducted by the jet Propulsion Laboratory at the California Institute of Technology in Pasadena. On the Mariner 9 mission, Sperry 1230 computers processed photographs of Mars taken from a spacecraft at distances varying from 76 to 146 million miles from Earth.

In the military area, the Defense Systems Division (DSD) has supplied several Naval Tactical Systems (NTDS) to the U.S. Navy and to warships of other nations in the North Atlantic Treaty Organization (NATO). Micro-electronic computers and advanced computing equipment for the Polaris/Poseidon submarine navigation system and airborne computers for the anti-submarine warfare program are examples of other equipment furnished by DSD to the Navy.

Among other significant Sperry contributions to the nation's defense programs was the provision of more that 160 computers for the U.S. Air Force's Base Level Supply Inventory Accounting system, and the installation of real-time computers for the Defense Department's AUTODIN (AUTOmatic DIgital Network) high-speed, worldwide communication systems.

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Early in 1983, the U.S. Air Force awarded Sperry a $520 million contract (in its first stage), known as Project Libra-Phase Four, to update the Base Level Supply Inventory Accounting system.

At that time, this was considered to be the largest single commercial computer order of its kind on record. Among the first non-military applications of Sperry real-time computers were systems supplied for processing airline reservations and for air traffic control by the Federal Aviation Agency.

The ARTS III computed-aided traffic control system, organized around Sperry systems, is generally considered to be one of the best air traffic control advancements.

Beyond the numerous computer systems used in air transportation, Sperry customers represent a diversified range of interests (engineering laboratories, petroleum concerns, geophysical exploration firms, manufacturing companies, banks, savings and loan associations, insurance companies, stock brokerage companies, distributors of financial information, newspapers, hospitals, universities, and state and local government agencies).

Computers from Sperry continually included new technology advances in the state of the art. From such earlier models as the LARC, the UNIVAC II and III, and the Solid State System came many advances incorporated into newer models. The Sperry 1107, announced in 1962, was the first commercial computer to employ thin-film memory. The 1100/20 and 1100/40 systems, introduced in March, 1975, marked the first use of semiconductor integrated circuits in the main processors of large-scale Sperry computers.

Sperry's growth curve took on a new dimension in January 1972, when the company acquired RCA's former computer customers and assumed responsibility for providing hardware and software support to these users in the United States, Canada and Mexico.

This customer base included 1000 computer installations and 500 customers. In addition, about 2,500 professional personnel, formerly with the RCA computer organization, joined Sperry.

Sperry entered the minicomputer market in 1977 by acquiring Varian Data Machines, a subsidiary of Varian Associates, Palo Alto, CA.

In October 1982, Sperry announced its entry into the office systems market with the introduction of the SPERRYLINK™ office system.

To reinforce their technological leadership, Sperry then became active in joint ventures with other companies. Early in 1983, Sperry joined Microelectronics Computer Technology Corp. (MCC), a consortium formed by 12 American companies headquartered in Austin, Texas. MCC's objectives were to share the high costs of research and development, to stay abreast of the worldwide developments in computer technology, and to keep the United States in the leadership position in advanced research.

Headquartered in Blue Bell, PA, the Computer Systems unit of Sperry served more than 15,000 customers in 50 countries.

BURROUGHS

In 1885, at the age of 28, William S. Burroughs filed an application for his first patent, establishing priority for the adding and listing machine. He didn't actually invent the adding machine in the sense that he created it from nothing. (Calculating devices had existed for centuries, at least since the abacus.) He combined existing technologies to build the first practical adding machine, which was manufactured by the newly formed American Arithmometer Company, renamed the Burroughs Adding Machine Company in 1905.

In 1944, Burroughs was awarded an Army-Navy "E" for outstanding achievement in the production of war material, principally the Norden bombsight, which made accurate high-altitude bombing possible and was considered by some military authorities as the single most significant device in shortening the war.

In 1949, permanent facilities for electronic research and development were established near Philadelphia. Three years later an Electronic Instrument Division was established in that city to manufacture and market scientific instruments and electronic memory components and systems.

The emphasis on electronic products resulted in a series of innovative banking and accounting machines called the Sensimatic, which was produced by Burroughs in the late 1940s. In 1950, the company introduced the first Sensimatic accounting machine with programmed control panel, a product considered the greatest advance in accounting machines in 25 years. In 1951, experiments began at the company's research and development center, which were aimed at developing a series of computers specifically for business problem solving.

In parallel with Burroughs development of electronic products for accounting applications, the company expanded its capability for development of larger, multipurpose computer systems. The Burroughs memory system, built in 1952 for ENIAC, the world's first electronic computer, increased the computer's memory capacity sixfold and demonstrated the company's capability in electronic computation.

With the acquisition of several companies in the late 1940s, and early 1950s, Burroughs began to diversify its operations. Burroughs acquired the Electro-Data Corporation of Pasadena, California in 1956. Electro-Data, a leading producer of computing equipment, provided Burroughs with much needed engineering and manufacturing capacity. The same year Burroughs Great Valley Laboratories were opened in Paoli, PA.

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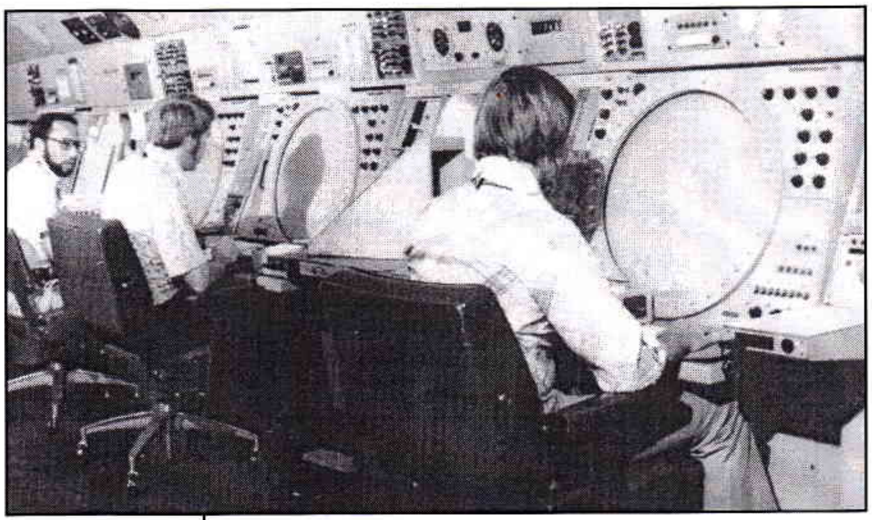

The ARTS II system, manufactured in Paoli, PA for the PAA by the Custom Products Group of Burroughs Corporation, is used to control air traffic at 96 small and medium-sized airports in the U.S.

Burroughs development of a full range of computer systems progressed steadily. The B 5000, introduced in 1961, was regarded as the most advanced business and scientific computer offered by any manufacturer. It departed from traditional concepts of computer design and featured such pioneering concepts as automatic multiprogramming, exclusive use of compiler languages, Burroughs Master Control Program, and virtual memory.

The B 5000 was followed by the more powerful B 5500 system in 1964, as Burroughs began its family approach to computer design. The 500 family served a broad cross-section of data processing requirements in fields such as banking, manufacturing and government.

Burroughs' success at solving business problems took a further evolutionary step in the late 1960s with the introduction of the Series TC terminal computers and the series L mini-computers. As developments in microcircuitry were applied to Series TC and Series L systems in the 1960s and 1970s, the systems evolved from electromechanical machines to fully electronic computers.

The early programs to expand Burroughs electronic capabilities also resulted in the company being awarded numerous government and defense contracts. Burroughs computers were used by the United States Navy in its POLARIS program and by the U.S. Air Force in the SAGE, ALRI, and BUIC Continental Air Defense networks. In 1961, Burroughs was named by the Air Force as hardware contractor for the NORAD combat operations computer complex and data display system.

During this time, Burroughs was also an active participant in the U.S. space program. The world's first operational transistorized computer, produced by Burroughs in 1957, was used in guiding the launch of the Atlas Intercontinental Ballistic Missiles. A later version of this computer guided every launch in the Mercury and Gemini programs of manned space flights.

With the completion of the first space rendezvous, made in 1965 between Gemini VI and VII, Burroughs guidance computers had handled more than 300 successful missions without failure, error or delay.

Throughout Burroughs' extensive involvement in electronic research, defense projects, and the space program, the company remained in the forefront of the commercial market by supplying a variety of products for banking and business.

The 1970s saw the further merging of Burroughs electronics and computer development efforts of the previous two decades. The decade also marked Burroughs entry into other areas of information management, principally office automation.

Burroughs Series TC and Series L electronic systems, which had been introduced in the late 1960s, were continually refined for various business applications. These refinements, along with continued electronic developments, led to the introduction of the B 80 series of small-scale computer systems in 1976.

Burroughs also continued to place strong emphasis on the development of lager computer systems during the 1970s. Following the successful 500 family of computers, the 700 family was introduced between 1971 and the end of 1975.

In late 1975, Burroughs began introducing the 800 family of systems with the announcement of a series of computers designed for medium-to-large-scale applications.

In 1979, Burroughs announced the first models of the 900 family of systems. The 900 models typically occupied half the space and required 50 percent less power to operate than the 800 family models.

The Burroughs expansion in data processing was paralleled by its entry into the office automation market. The company entered the facsimile communications market in 1975. In 1979, the company added an optical character recognition page reader system to this growing range of office automation products, which became an increasingly important segment of Burroughs "total solution" approach to information management.

In the early '80s Burroughs, together with Convergent Technologies, introduced the B 20, a family of powerful microcomputers.

In software, Burroughs introduced a new product called LINC (an acronym for Logic and Information Net-

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work Compiler) that actually wrote other programs for a wide variety of business situations. Since you didn't have to be a professional programmer to use it, LINC put the power of the computer in the hands of a great many more people.

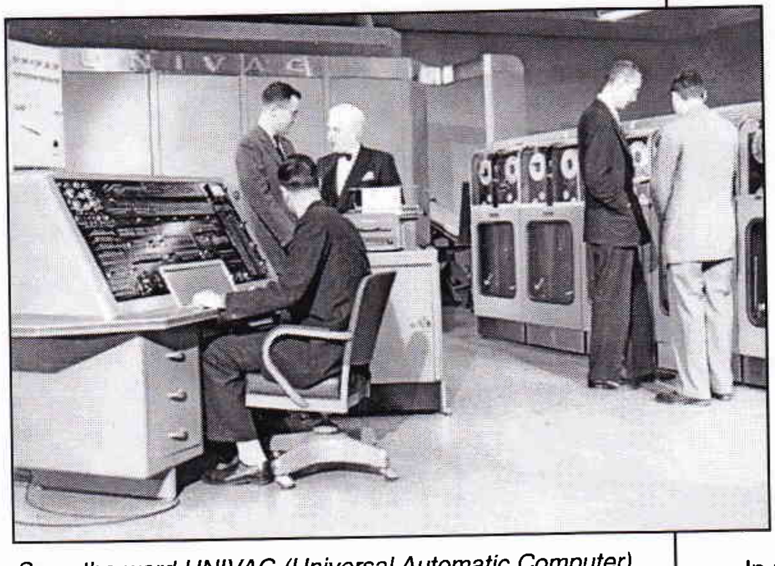
In 1986, Sperry and Burroughs, two giants of the computer industry, joined forces to form Unisys Corporation. Sperry introduced the 2200 Series, a forerunner of the current ClearPath HMP IX system. In 1989, Unisys introduces Micro A, the first desktop single-chip mainframe computer.

In the 1952 presidential election, the newly developed UNIVAC I computer correctly predicted a landslide victory for Dwight D. Eisenhower over Adlai E. Stevenson. Walter Cronkite, CBS News, right, waited for the UNIVAC's prediction along with co-designer J. Presper Eckert Jr., center. The "giant electronic brain" made its forecast early in the evening. So early that the news media waited to confirm it with the actual vote counts across the nation. UNIVAC co-designer John W. Mauchly was the other half of the dynamic team that first sparked the computer revolution with the development of ENIAC at the Moore School of Engineering at the University of Pennsylvania. Together, Mauchly and Eckert were prime movers in bringing the concept of an all electronic large-scale computer from concept to reality. Philadelphia, known for starting everything from the American Revolution to the Slinky, was the site of development and manufacturing for production of UNIVAC. First order was to the U.S. Census Bureau in 1951. *(Photos courtesy of Unisys Corporation.)*

UNISYS

Unisys carries forward the heritage of innovation established with UNIVAC today with the Unisys Enterprise Server ES7000. This is the first computing platform to bring mainframe-class, standards-based computing to the Microsoft Windows environment, providing enterprise-class scalability, uninterrupted availability, flexible resource reallocation, easy systems administration management and customer support that make the concept of the Windows-based mainframe a reality. The Unisys Cellular MultiProcessing server architecture on which the ES7000 server is based is capable of supporting a single 32-processor image of Windows. It was designed in anticipation of the advanced scale-up characteristics of the operating system. For most of the two years since the announcement of Windows 2000 Datacenter Server, the Unisys ES7000 has been the only server platform to take full advantage of the operating system's ability to scale to up to 32 processors.

In that brief period of time, enterprises have seen the performance of ES7000 servers reach levels that once could only be achieved by much more expensive UNIX-based systems. More recently, the combined technologies have nearly doubled those performance levels.



Soon the word UNIVAC (Universal Automatic Computer) came to mean computer. Other government agencies like the U.S. Navy and large commercial companies like General Electric were soon lining up for a UNIVAC to tackle the challenges of high-volume transaction processing previously done with manual and mechanical means. *(Photos courtesy of Unisys Corporation.)*

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Unisys has not only taken advantage of the advanced enterprise-capable features built into the Microsoft Windows 2000 Datacenter Server operating system, it has had a shaping hand in defining their design and engineering their execution. Important examples of mainframe-style capabilities include change management, configuration audits and the ability to reallocate resources within a system to meet unanticipated shifts in workload. Unisys is playing a key role in bringing dynamic partitioning, a critical mainframe capability that enables administrators to move workloads to alternate computing resources without reboots, to the Windows 2000 Datacenter Server.

RCA

RCA BIZMAC

BIZMAC (Business Machine), an electronic data processing system containing 27,000 tubes and 67,000 diodes and occupying an area equal to a football field (including the end zones), was built by RCA Engineering Products Division, Camden, NJ. The system, delivered to the US Army Ordinance Tank Automotive Command, Detroit, MI in December, 1956, was the world's largest electronic brain at the time. The $5 million system was placed into operation in October 1957, and it successfully tracked over 100 million tank and automotive spare parts in the Army's worldwide inventory.

RCA Camden

RCA BIZMAC

In 1958, RCA launched its major venture into the electronic data processing field with the introduction of the RCA 501, a medium-sized commercial business computer and the first fully transistorized system in the industry. By 1960, the Corporation had introduced the compact RCA 301 for medium-size and small businesses, and had announced a coming third entry, the RCA 601, for large enterprises and scientific computation.

RCA 501 Computer.

In 1959, RCA introduced DaSpan, a computer-to-computer communications system that could span a continent, and gather and coordinate vital data from the many plants of a large industrial enterprise.

The same computer-communications know-how made RCA the supplier to Western Union, the prime contractor of an automatic electronic data switching system for the Air Force Control Logistics Network (ComLogNet) linking 350 bases and stations across the country in the world's most advanced communications systems.

Progress in circuit design and system concepts led to a major step forward, in 1964. RCA introduced the Spectra 70 series, the first in the industry of a new third gener-

RCA Computer Center, Cherry Hill, New Jersey.

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RCA Camden Computer Milestones are tabulated below:

Milestones:	Significance:
1950 — A joint RCA Laboratories-RCA Camden team, sponsored by the US Navy under the title Project Typhoon, demonstrates a computer containing 4,000 electron tubes that evaluates performance of guided missiles, ships, submarines, and airplanes.	The largest and most accurate electronic analog computer built to that date to evaluate performance of guided missiles.
1952 — RCA Camden initiates an intensive $10.6 million R&D program in electronic systems for computing, sorting, filing, and recalling large quantities of data.	Marks RCA's entry into the fledgling computer business.
1956 — BIZMAC electronic data processing system is built by RCA Camden, and delivered to the US Army Ordinance Tank Automotive Command in Detroit, in December.	The world's largest electronic brain at the time. The $5 million system, placed into operation in October 1956, successfully tracks over 100 million tank and automotive spare parts in the Army's worldwide inventory.
1957 — Following the successful delivery of its first BIZMAC a year earlier, RCA produces a second for the New York Life Insurance Company, and a third for the Travelers Insurance Company, Hartford, CT. Each systems covers 25,000 square feet of floor space, is composed of 357 separate units, and contains over 25,000 electron tubes.	The BIZMAC system for Travelers Insurance Company is, at this time, the largest commercial, multi-computer system in the U.S.
1959 — With the advent of solid-state devices and after three intensive years of research in the use of transistors to implement the logic of electronic data processing systems, RCA introduces the RCA 50 business computer.	The world's first all-transistorized business computer.
1959 — RCA introduces DaSpan, a digital communications system that links a central computer with numerous remote stations via telephone or telegraph lines.	DaSpan allows two-way computer-to-computer communications across the entire U.S., providing an efficient and economic means to gather and sort large volumes of data for companies with locations scattered across the country.
1959 — Under subcontract to Western Union, RCA begins development of an automatic electronic data switching system for the US Air Force Combat Logistics Network.	Following installation of systems at five U.S. Air Force bases in February 1963, the network is activated as the Data Communications (DATACOM) Network, representing the keystone in the nationwide Automatic Digital Network (AUTODIN).
1960 — RCA introduces the RCA 301 Computer System for small business applications and the RCA 601 for large enterprises in April.	RCA expands its computer product line, following the success of the RCA 501 (world's first) all transistorized business computer two years earlier.
1963 — RCA introduces the 3301 Realcom business computer, providing data processing, high-speed communications, real-time management control, and scientific computation.	The first business computer to span the full range of data handling capabilities in a single system.
1964 — Continuing engineering advances at RCA Camden leads to the introduction in December of the Spectra 70, a new series of third-generation RCA business computer systems.	The first commercial computer system to use monolithic integrated circuits.

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SPECTRA 70/61

ation of computers. The group initially included four compatible general-purpose computers — two of them employing the first monolithic integrated circuits to be used in the commercial equipment. A fifth model was added in 1965.

Another significant trend was the growing relationship between computers and communications — but in the development of computer-to-computer links and in the use of computers to increase the speed and flexibility of communications.

RCA introduced several advanced terminal devices during the 1962-1966 period for communication between computers and users. Among them were a voice response unit that provided spoken replies to inquiries telephoned directly to a computer, and a self-contained video display unit employing integrated circuitry.

At the end of 1962, the product line consisted largely of the 301 system for medium and small business enterprises, and the larger RCA 601 for industrial and scientific use. In 1963, a versatile new unit, the 3301 Realcom, was added to the line as the first computer designed to span the full range of data handling capabilities in a single system — business data processing, high-speed communications, real-time management control, and scientific computation.

In the same year, a significant adjunct to these systems was introduced in the RCA 3488 mass memory, designed to hold several billion characters and to operate with either the 3301 or the 301.

The Spectra 70/46 was introduced in 1967 and the large-scale Spectra 70/61 two years later to serve the growing market for remote computing systems. These two remote computing systems were the first RCA processors equipped with virtual memory (the main computer memory could be expanded almost limitlessly through a series of auxiliary devices and specially developed software).

However, RCA did not concentrate entirely on remote computing. In 1969, the company marketed a large-scale Spectra 70/60 batch processor designed to handle credit and reservations systems, automate production control, and serve data banks. The following year, RCA introduced a new series of small-to-medium-class computers — the RCA 2, 3, 6, and 7. Two of these new processors also had virtual memory.

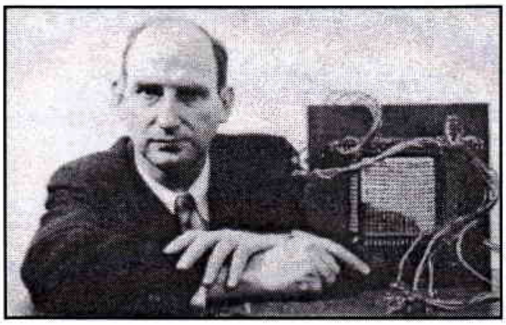
Progress was also made in electronic composition systems. The speed of the RCA Videocomp was increased tenfold in 1968, making it possible to set the text of a novel the size of War and Peace in less than an hour. Two later developments further enhanced its capabilities: the ability to set complex line drawings and then position the drawings on a page together with text and the development of a program that enables the system to produce halftone photographs composed of small ideographic characters.

In the second half of 1971, RCA withdrew from the general-purpose computer business. Adverse business conditions, a uniquely entrenched competition, and the need for continued massive infusions of capital led to this decision by RCA.

RCA Princeton (David Sarnoff Research Lab)

RCA Laboratories' research in computer technology dates back to the late 1940's when research in magnetic ferrite materials led not only to the development of shorter television tubes with larger picture area, but also to the development of ferrite memory cores for computers.

In 1947, the Selectron, an electrostatic storage tube with a matrix of 256 small memory elements for computer use, was developed. It was the first binary digital computer memory.



Ferrite Core Memory and Dr. Rajchman.

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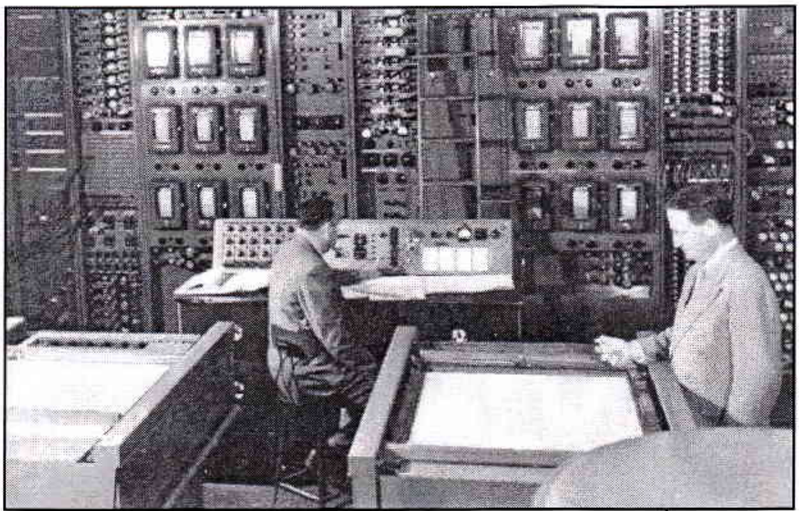
Typhoon Computer

tems software than any other computer services company in the industry.

CSC went public in 1963, and was listed the following year on the Pacific and American stock exchanges, becoming the first software company to be listed on a national exchange. Five years later, the company again brought new stature to the emerging software/services industry by being the first software company to be listed on the New York Stock Exchange.

CSC has transformed the $100 with which its founders established the company into annual revenues of $11.3 billion and approximately 90,000 employees worldwide.

CSC was built through a long and successful track record in acquisition — 83 companies have been acquired in the last 17 years, with the latest being DynCorp. More than 57,000 experienced professionals have joined CSC through these acquisitions, which were made to add new capabilities, increase resources, and expand global coverage. Additionally, over the years more than 26,500 experienced professionals joined CSC through outsourcing for many of the nation's major firms, adding critical skills and competences.

In the Tri-State area surrounding greater Philadelphia, CSC has a strong and visible presence in Bucks, Chester, Delaware, Montgomery and Philadelphia counties in PA; in Atlantic, Burlington, Cape May, Camden, Cumberland, Gloucester, and Salem counties in NJ; and in Delaware and Maryland.

About 3,000 CSC employees work in these four states, including a major portion in CSC's Federal Sector providing service and support to national, state and local governments. Additionally, CSC provides services to many major clients around the United States from these locations, especially in data centers in Wilmington and Newark, Delaware.

CSC's major organizations have worked on projects throughout the Tri-State area, from Web access center design and implementation planning for Children's Hospital of Philadelphia to providing maintenance, repair, improvement and operations services for all federal government property at the Defense Supply Center in Philadelphia. CSC has provided remote claims processing and MIS services for Christiana Care Health Plans. CSC was also responsible for the managed care software for Independence Blue Cross, the region's largest health insurer. Additionally, in the Wilmington area, E.I. DuPont de Nemours Co. — DuPont — which has 20 strategic business units, has been a major CSC client for years.

Recently the Army's Logistics Modernization Program (LMP), designed and developed in Moorestown, NJ, was deployed to several locations throughout the united States to include Tri-State locations: the Army's Communications and Electronics command at Fort Monmouth, NJ; Tobyhanna

In 1950, the Laboratories built Typhoon, the world's largest and most accurate electronic analog computer, for the U.S. Navy to evaluate performance of guided missiles, airplanes, ships and submarines. It could work out a complex air-defense problem employing a theoretical guided missile in one minute, a record achievement at the time.

The continuing work in computer memories and components, aided by advances in materials technology and solid-state physics, to such developments as (1) the laminated ferrite memory, the highest speed, most compact ferrite memory ever achieved; and (2) the cryoelectric memory, a large-scale memory using superconductivity to achieve its high capacity and high-access speed.

COMPUTER SCIENCES CORPORATION

In April 1959, Roy Nutt and Fletcher Jones, both in their late 20s, formed Computer Sciences Corporation with $100 and a contract from Honeywell to develop a business-language compiler called FACT. Formerly with United Aircraft Corp., Nutt had developed the first widely accepted assembly program, called SAP, and had been a member of the small IBM team that had developed FORTRAN. Jones came from North American Aviation Corp., where he had managed a divisional computer center.

Assembling a small staff of talented people, CSC soon gained a reputation for innovative design and high-quality work. With Nutt providing the technical direction and Jones handling the marketing, the young company prospered. Through its work for numerous computer manufacturers and other large computer users, CSC developed more sys-

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Army Depot in PA; and a portion of the Army's Soldier, Biological, and Chemical Command located in Philadelphia.

The Army Materiel Command (AMC) took a giant step in the Army's transformation process with this first deployment of the LMP for the first 4,000 users in the Tri-State area and several other locations throughout the United States.

AUERBACH

Auerbach Corporation for Science and Technology was founded in July 1957, by Isaac L. Auerbach. The company's subsidiary, Auerbach Associates, Inc., was the first computer consulting company in the United States, if not in the world. It was spearheaded by Auerbach and two of his associates, Arnold B. Shafritz and Paul Winsor III, all of whom left the Burroughs Defense Space and Special Projects Group, in Paoli, which they created by successfully applying advanced computer technology to real-time defense projects.

Auerbach Associates became world renown for its creativity and unique computer system architecture and digital communication systems design. These people were one of the country's earliest and foremost leaders in the application of computer technology and programming to online, real-time systems. Examples of their innovations can be identified in system projects such as air traffic control, airline reservations, air defense systems, store and forward data communications and industrial control.

Another of the parent company's subsidiaries, Auerbach Publishers, Inc., was the first company dedicated to publishing updated loose-leaf information about computer hardware, software and systems, and the management of computers and communications.

GESTALT, LLC

A relatively new software/information systems company has been operating within the Philadelphia Section for the past eight years with offices in King of Prussia, PA, and Camden, NJ. The 75 employees specialize in developing middleware for "Interoperability." This middleware ties together legacy systems with new systems and allows for data base collaboration. For the Defense Department, Gestalt ties together multiple Command & Control systems, as well as tying Command & Control systems to Simulations. **In 2003, Gestalt received two prestigious awards: The 2003 IEEE Philadelphia Section Corporate Innovation Award and the AIAA Project of the Year Award.** The USAF Electronics Systems Command, credits Gestalt with saving their training budget by a factor of four through the use of their middleware. A new US Army CECOM Contract calls for Gestalt to develop a "Proxy Server" which will tie together a German Command & Control System with an Army Command & Control System as well as the US ONESAF Simulation. Other Countries will be added in 2004, and the Proxy Server Methodology will be used by the Army for Coalition Interoperability.

MOS TECHNOLOGY

In August 1974, a team of engineers at MOS Technology in the Valley Forge Corporate Center in Norristown began the design of a revolutionary new NMOS 6502 microprocessor that became the heart of the first Personal Computers from Apple Computer and Commodore Business Machines. Also, this same microprocessor was used in the first video game machines from Atari and Nintendo. The first samples of production chips were sold for $25 in the St. Francis Hotel in San Francisco during the Wescon Conference held in September 1975.

In 1996 at the Comdex Conference in Las Vegas, Nevada, in celebration of the 25th anniversary of the introduction of the microprocessor, the 6502 was honored as the first of seven microprocessors "because they were seminal in nature and incredibly innovative for their time". In short the 6502 was honored for its contribution to the Information Technology industry. The 6502 was the heart of two of the most valuable electronic system markets — the first high volume PCs and video game systems. Two of the 6502 designers, William D. Mensch, Jr. and Charles I. Peddle accepted the award given to the 6502 microprocessor.

In addition to the 6502 microprocessor the MOS Technology 6522 Versatile Interface Adapter (VIA) was used as the mouse interface in the Apple Macintosh Personal Computer.

William D. Mensch, Jr., who was born in Quakertown, worked at Motorola as one of the designers of the 6800 microprocessor. He went to MOS Technology in 1974 where the 6502 was designed. After leaving MOS Technology in 1977, Mr. Mensch went to Arizona where he worked at Integrated Circuit Engineering, a consulting firm. In 1978 he formed his own company, The Western Design Center, Inc. (WDC) in Mesa, Arizona, where he created the CMOS W65C02 microprocessor, which was used in the Apple IIc and IIe as well as the W65C816 used in the Apple IIgs and Super Nintendo. Mr. Mensch holds 22 patents in microprocessor and microprocessor system design. In 1991 and again in 1996, Mr. Mensch was honored by the Microprocessor Forum as one of ten pioneers in the microprocessor industry. He was inducted into the Computer Hall of Fame in 2002.

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— INSTRUMENTATION —

MOTOROLA

(Connecting Consumers to Entertainment — Over 50 Years of Innovations from Motorola Broadband.)

The year 1948 marked the foundation of the company that today is now known globally as Motorola Broadband. Back then, the notion of connecting homes to a wired network that delivered television programming was a radically new concept. Today, the evolution of those first cable television networks keep consumers informed, entertained, and connected like never before — through digital content, high-speed Internet access, video-on-demand (VOD) home networking, and more. Through it all, Motorola Broadband has continued to drive the industry forward, working to develop innovative new technologies and services.

Motorola Broadband began as Jerrold Electronics, a manufacturing company started by Milton Jerrold Shapp, the former governor of Pennsylvania. The company's first product was a signal booster, designed to enhance "snowy" pictures on a television screen. In his previous job as a door-to-door electronic parts salesman, Shapp foresaw a future market for such a gadget, especially as television sales were growing in the late 1940s and early 1950s.

To promote these signal boosters, Jerrold pioneered a "master antenna television system" (MATV) that would allow store showrooms to display more than one active TV at a time. In 1950, when a Philadelphia department store first used Jerrold equipment to show off multiple TVs, the technology was so exciting that the newspapers covered it.

The early success of MATV attracted the attention of a Lansford, Pa. appliance dealer, who wanted to sell television in the region located between Philadelphia and New York. Sales were slow because the area was shielded from the signals broadcast from the major metropolitan areas where television was just getting started. To compensate for the lack of signal, the dealer, Bob Tarleton, propped an antenna on a nearby mountain and ran coaxial cable into town, boosting the signal using specially-redesigned Jerrold MATV amplifiers. The multi-billion dollar cable television industry was born.

From its headquarters in Hatboro, Pa., Jerrold Electronics continued to bring new innovations to the fledgling industry. The company expanded its product lines, providing everything entrepreneurs needed to build cable systems. In 1956 Jerrold introduced the "Golden Cascader" distribution amplifier that increased channel capacity from three to five.

Over the next few years, the greatest minds in the cable industry were occupied with the challenge of increasing channel capacity, and Jerrold was on the forefront of that innovation. The company's "Golden Cascader" distribution amplifier was introduced in 1956, increasing channel capacity from three to five. In 1959, Jerrold increased capacity to a full 12-channels, with a 216 MHz amplifier that would set the industry standard for the next six years.

In 1968, Jerrold again expanded channel capacity from 12 to 27, and for the first time, cable television could supply significantly more channels than available from over-the-air broadcast television. To help consumers receive those channels, Jerrold created the first set-top box — a 20-channel electro-mechanical cable converter displayed at the 1967 National Cable Television Association (NCTA) annual convention and exhibition. The company expanded on that development, introducing the industry's first remotely controlled set-top, in 1972.

From its beginning, the company has been involved in more than just bringing technology to market. The Company's history of working with partners to develop profitable business models stems back to 1958, when the Company helped to facilitate the first pay-TV experiment, in Bartlesville, Oklahoma. With the cooperation of a local theater owner and Columbia pictures, Jerrold technology brought the Pajama Game to television, before it hit the movie screen.

During the 1970s, spurred by the introduction of HBO, many premium entertainment networks were launched. Jerrold introduced multi-level scrambling/descrambling in 1979, helping cable operators offer multi-level product tiers for pay and basic programming.

Throughout the 1980s, Jerrold technological innovations paced the cable television industry. The Company introduced a store-and-forward mechanism for two-way cable plants, which boosted the developing pay-per-view industry by allowing consumers to order a show using a remote control. Jerrold also set industry standards in bandwidth, reaching 550 MHz distribution in 1983 and 750 MHz by 1989.

By 1990, Jerrold entered its sixth decade as the leading provider of technology for the cable industry. Now known as General Instrument Corporation (GI), from an earlier acquisition, the Company continued to drive the industry forward, with new ideas and new products.

GI was the first to bring a proposal to the Federal Communications Commission (FCC) for transitioning from analog to digital technology to drive high-definition television (HDTV) — a concept that no one else had considered. By the mid-1990s, GI had worked with Comcast Cable Corporation in the first volume commercial deployment of a digital cable system. Two years later, GI had shipped more than one-million digital cable set-tops — a number that would increase to ten million by the year 2000. By the end

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of the decade, the Company had added the first volume deployments of Internet access via cable (1998) and video-on-demand (1999) to its list of impressive accomplishments.

In 2000, General Instrument merged with Motorola, in a deal that brought together the industry leader in cable networks with a global leader in wireless communications. GI's cable technologies would be part of a newly formed business unit that combined the Company's historical success in building advanced networks with Motorola's brand and retail marketing experience. The Motorola Broadband Communications Sector would bring the power of the broadband network right to consumers.

Today, Motorola Broadband supplies the products that allow consumers to experience a "connected home." The Company is the world's leading supplier of such proven home gateway products as digital set-tops (with more than 27 million shipped) and cable modems (with more than 13 million shipped), yet continues to innovate just as it did in the early years. In 2002, the Company introduced the industry's first integrated wireless cable modem gateway, and the first home theater system to integrate a digital cable box. Earlier this year, the Company announced a digital set-top that combines digital video recording (DVR) with high-definition television (HDTV). Motorola will continue to bring plug-and-play consumer electronics devices to market, helping consumers customize their home entertainment experience.

Motorola continues to provide cable operators with a solid network foundation, offering solutions that span head-end processing, transport, encoding, and modulation. The Company is one of the leading innovators in metro optical networking, GigE, and VOD transport. Further, Motorola MediaCipher® is recognized worldwide as the leading conditional access system, providing content providers with an unsurpassed level of security.

Credited with more than 50 years of innovations, Motorola Broadband continues to be a driving force in the development of new technologies. True to its roots, the company continues to connect people to information and entertainment, making their lives simpler and keeping them in sync with the things that are important to them, all through the power of broadband communications.

MOORE PRODUCTS

Founded as Moore Products Company in 1940, the company leased an 1800 square foot second floor on North Lawrence St. in Philadelphia, PA. After 6 years in business, Moore Products created a major stir in 1946 with the introduction of its Nullmatic "stack" controller based upon principles C.B. Moore first published in 1945. Large case instruments were the standard in instrumentation in those days. Panel boards were huge and unwieldy and, it seemed, destined to stay that way. However, at the annual Instrument Society of America Show in Buffalo in the fall of 1947, Moore Products Co. introduced its new miniature control station that was piped to the stack controller. This station was a panel-which allowed the control room operator to manipulate and monitor the process control loop.

The 1950's were good years for Moore Products Co. It was a period of steady growth during which the Company established itself within the industry. Moore added a third plant and the first international operations began. New products introduced early in the decade included automatic dimensional measurement gages, leak test cabinets, differential pressure transmitters and an expanded variety of pneumatic relays. Top-mounted positioners were added to the valve positioner line. These products would provide steady business for decades to come.

By 1963, C.B. Moore had become one of the most recognizable men in the industry. Electronic controllers had been introduced in 1954, setting off the debate that would go on for nearly two decades. C.B. Moore quickly became one of the most successful, and entertaining, defenders of pneumatics as the superior and safer approach. Among other attention-getting devices, he would dip his hand (or a dollar bill) in alcohol and set it afire with an electronic device which emitted a current level less than that used by electronic control systems in order to demonstrate an inherent danger in those early devices.

Moore Products Co.'s wait-and-see approach was a logical decision, the wisdom of which is apparent in retrospect, since it was not until the introduction of integrated circuits in the late '60s that the real development of electronic controllers took place.

Moore Products was purchased by Siemens Energy & Automation, Inc., early in the year 2000. To fit with the overall Siemens product marketing structure, the previous Moore company was divided into three business units: the process systems business, the process instrumentation business, and the discrete measurement business. About the same time, Milltronics, Inc. Of Canada was purchased by Siemens of Canada. The Milltronics division in the US was merged with the former Moore process instrumentation business to form the current Process Instrumentation Business unit of Siemens Energy & Automation. The Process Instrumentation business joins the systems business and the analytics business in the newly formed Process Solutions Division of SE&A.

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GENERAL ATRONICS (DRS TECHNOLOGIES)

In 1955, David E. Sunstein left Philco where he was Associate Director of Research to become a private consultant. He opened offices on the third floor of a home on City Line in Bala Cynwyd, PA. Four other Philco engineers —George Laurent, Glenn Preston, Robert Roop, and Bernard Steinberg — joined him and together they formed General Atronics Corporation in December 1955. The story was often told that the name "Atronics" was coined by one of their wives under the influence of an unspecified number of martinis. The company rented offices in the basement of One Bala Avenue. Their interests were almost exclusively R&D. The first portable implantable heart pacemaker was invented by a General Atronics engineer. Innovative radar and communications equipment go to their start at One Bala — PRSD, Wholesale RAKE, KATHRYN, a sweep integrator, and more. Much of the worked was on the BMEWS (Ballistic Early Warning System) program for RCA.

By 1961, General Atronics had outgrown the basement and moved to its own building in West Conshohocken where, among other things, they worked on underwater communication devices and, in a branch office in Boston, trained carrier pigeons to read maps.

In 1964, General Atronics bought Electronic Tube Corporation in Wyndmoor, PA; the building was enlarged to provide offices and laboratories for the General Atronics engineers. Mr. Sunstein moved to new offices on Mermaid Lane and, when the addition was completed, the rest of the company relocated. Mr. Steinberg was the only co-founder to make the move; the others had all spun off with their own businesses. Soon space was again at a premium and Atronics rented part of the Voron Building in back of the Mermaid Lane building to house their new computer and the VELA group, working on seismic detection.

Magnavox acquired General Atronics in 1969, and soon after the company was forced to cut back its unmanageable large number of diverse activities and focused on HF radio data transmission and adaptive RF cancellers and arrays. The accompanying staff reduction and management reorganization gave them plenty of room. Mr. Sunstein left the company in 1970 and again became a private consultant; he died in 1979. In 1974, North American Phillips merged Magnavox into their family and General Atronics went along for the ride.

Several companies got their technology start from General Atronics. Atronics' engineers developed Magnafax, one of the first fax machines. The rapid reading bar codes during pill and bottle sorting for a pharmaceutical company led to a large now well-known local company dedicated to the high speed sorting process. General Atronics also developed the technology and produced more than 2.5 million RF tags used initially for tracking library books.

In 1984, a joint venture was created between General Atronics and Hollandse Signallapparaten of the Netherlands (Signaal) called the Magnavox Signaal Systems Company. The primary purpose was to conduct business with the U.S. Department of Defense, and other Ministries of Defense, manufacturing products and systems under a technology transfer agreement with Signaal. Thales eventually acquired Signaal, but the technology transfer agreement continued and thrived. Since its inception, the joint venture has successfully developed, built and delivered several surveillance, tracking, communications, and data handling systems — all proudly made here in the USA.

But changes for General Atronics were not over. In 1991, the management team of George Huffman, Howard Drown, and Dr. Michel Goutmann, brought General Atronics, and the majority position in the joint venture from Phillips. Huffman kept the General Atronics name and shortened name of the joint venture to MSSC. They managed the company, and its growth in ground, ship and airborne data link products through the turn of the century — nearly 45 years since its founding. After nearly nine years of being a "small company" again, DRS Technologies acquired General Atronics in June of 2000. With the acquisition came a name change to DRS Communications Company.

Today, DRS Communications Company provides data link communications, cryptographic, radar, and imaging systems for command and control of naval vessels and selected ground based systems. Well on its way to integrating technologies with its sister companies and establishing its position as a center of excellence within DRS Technologies, their customer base includes the U.S. Department of Defense, related agencies, and Ministries of Defense around the world.

DYNACO


David Hafler

David Hafler, of Rittenhouse Square in Philadelphia, was an audiophile who devoted his life to perfecting home high-fidelity sound components.

A resident of Merion Station, PA, before moving to Rittenhouse Square, Mr. Hafler owned homes in Boca Raton, Florida and London, England filled with music from quality sound systems he designed himself. (He didn't watch television.)

Hafler received his mathematics degree from the University of Pennsylvania in 1940. He enlisted in the Coast

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Guard after the Japanese invaded Pearl Harbor. During the war, while serving as communications specialist in the Caribbean, Mr. Hafler was exposed to the notion that sounds could be reproduced faithfully.

After the war, Hafler worked for A.J. Wood, a market-research firm in Philadelphia, until his love for music spurred him to design easy-to-assemble electronic sound equipment for consumers.

In 1950, David Hafler founded Acrosound in Roxborough, PA, which built and sold audio transformers. It was his next venture, Dynaco, which he founded in 1954 in West Philadelphia, that set the standard for home music systems. Dynaco manufactured and sold amplifiers as build-it-yourself kits. At the time, the average hi-fi enthusiast had to assemble the parts for a home sound system. He sold Dynaco to Tyco in 1968 and served as an advisor until 1971.

One year later, he founded another company, David Hafler Company, in Blackwood, Camden County, manufacturer of inexpensive kits and pre-assembled hi-fi gear. He sold that firm in the early 1990s to Rockford Corp. or Tempe, Arizona.

In 1999, the trade magazine, Vacuum Tube Valley, said in a profile that Hafler "has probably been more instrumental in the development of component hi-fi or home use that anybody in the history of the industry." In 1984, he was named to the Audio Hall of Fame.

One of his products, the classic Dynaco Mk. II 50-watt amplifier, was part of the media display in the Smithsonian's Museum of American History in Washington, D.C., in the 1990s.

The theme to Hafler's life was that if he couldn't be a top player, he could be a top manufacturer. He loved music, but didn't play well enough to play professionally, so he manufactured the best sound equipment possible.

MAGNETIC METALS

In 1942 W. P. Langworthy started the Magnetic Metals Corporation in Camden, NJ, manufacturing stamped, heat treated laminations for the distribution of electrical power and fractional horsepower motors. RCA and fan manufacturers in the Philadelphia area were the main customers. The company expanded quickly into the fields of laminations for telecommunications through close cooperation with Bell Laboratories and Western Electric. Through the use of high-purity nickel-ron lamination, the company grew into a major supplier for the Bell System. Mr. Langworthy then hired a group of international R&D engineers and scientist in the 50's to develop new products, processes and test instruments for magnetic components. This resulted in new innovative products like high-permeability long E laminations of low distortion, controlled sizes of powder particles in nickel-iron cores with super square hysteresis loops for pulse generators and particle accelerators in cooperation with the University of Pennsylvania's LRSM Institute.

In the golden years of the magnetic amplifier the company started to produce tape cores in a new facility in Pennsauken, NJ, made square loop nickel-iron alloys by sintering powders for these tape cores and expanded into the production of Mopermalloy powder cores for telecommunications and into electromagnetic shields.

Shielded chambers with fields as low as a few gammas were built as well as low-cost shields for color television and chemically etched, magnetically shielding shadow masks. These developments came to a halt when RCA was sold to GE, the Bell Telephone system was broken up, and most of the Western Electric plants closed.

Luckily at that time a new requirement for supersensitive nickel-iron cores came about with the introduction of ground fault circuit interrupters, GFCI and hair drier protection: products found today in every house in the USA. These devices sense currents as small as 4mA missing from 15A currents and interrupt the current flow, thereby preventing muscle contraction or heart fibrillation in people touching the electrical circuit. Finally the ac current so dreaded by Edison was made much safer.

Magnetic Metals was a pioneer in the development of these devices and today produces millions of such devices for customers all over the world.

In 1977 Mr. Rowan purchased the Magnetic Metals Corporation. Mr. Rowan, owner of Inducotherm, is a major benefactor to the Rowan College in South Jersey.

Magnetic Metals is a good example of a company that has adapted its product lines to the requirements of this changing world and its markets. Although electricity is still produced according to Faraday's law, established in 1829, the generation, safe distribution and measuring systems for electricity are changing significantly. Magnetic Metals will play a vital role in that development.

KULICKE AND SOFFA INDUSTRIES

The 1951 partnership of Frederick W. Kulicke, Jr., and Albert Soffa evolved over 52 years into a worldwide innovative single-source semiconductor packaging assembly equipment and engineering provider, now headquartered in Willow Grove, PA.

The partnership began in Philadelphia with the Kulicke and Soffa Manufacturing Company working in a family attic and garage. The company expanded in 1953 to the second floor of a building at 110 West Pennsylvania

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Street, in Germantown and, in 1958, to more space at 447 Orianna Street in Philadelphia. Operations were subsequently consolidated at 1234 Callowhill Street, and in 1962, to 135 Commerce Drive in Fort Washington. In 1972, the company moved into a new 60,000 square foot plant in Horsham, PA, and in 1984 opened its Willow Grove headquarters.

During the 1950s, the company's products included the machinery to make metal edges for boxes, a case unloader and a machine to standardize the size of ground meat patties. Its journey to the electronic microworld began in the mid-1950s with a Western Electric contract to design a machine to connect tiny wires to a transistor. This micropositioner lead to K&S's first wire bonder. In 1961, K&S developed and manufactured an expanded line of capital equipment for the semiconductor industry. During 1976, K&S's automatic wire bonders improved the company to a dominant role in the marketplace. By 1979, the total world sales within the whole semiconductor industry reached $10 billion.

During 1981, the company introduced its 6300 die bonder, the 2406 semi-automatic wire bonder, and the 835 pattern recognition system for automatic wire bonders. In 1984, K&S increased its market by introducing the 797 wafer-dicing saw with a computer interface allowing it to be integrated into a factory automation system. In 1988, K&S began producing its 1484 automatic gold wire bonder. Its two largest customers, Motorola and National Semiconductors, had all of their 1484s in Asian facilities. In 1993, K&S introduced the new-generation 918 dicing system. Many new products were introduced in the late 1990s, including the acclaimed and best selling 8028 ball bonder.

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Date: Saturday, November 22, 2003 ***(Hold the Date!)***

Time: Registration & Continental Breakfast 8:15 AM
First Presentation starts **promptly** at 9:00 AM. Seminar will end by 4:00 PM

Location: Drexel Faculty Club, 33rd & Chestnut Sts., 6th Floor

Fee: Only $50 for Members, $75 for Non-Members; $10 for Student Members, $15 for Other Students (includes: continental breakfast, coffee & soda breaks, buffet lunch and notes)

Parking: Free — East side of 33rd Street between Walnut & Chestnut Sts.

Registration: See October *Almanack* for details.

- ***Get your boss to pay! Your improved communicaion skills will be worth much more than the price of the seminar fee. In fact, your boss might learn a great deal by attending with you.***
- ***Seven top notch presenters will captivate you, entertain you, and best of all motivate you to improve your communication skills and thus improve your promotability.***

Seminar Tentative Outline

1 Learning Better by Listening Better

2 Understand Motives and Agendas

3 Time Management

4 Killer Presentations: Six Secrets of Preparation and Delivery

5 Sales Strategies for Non-Selling Professionals

6 Self Achievement & goal Setting

7 Projecting a Professional Image